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Green Data Centres in a Low Carbon Economy

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Issue

Information technology, in particular data centres, consumes large amounts of energy. As reliance on digital information and storage increases, so too will the energy needs and related emissions. The creation of green data centres offers a solution to this issue, and would be a highly appropriate initiative for British Columbia given our existing low-emissions hydro-electricity supply and potential for additional power from renewable sources. Moving on this opportunity would create positive environmental impacts, reduce carbon emissions, and present new business prospects for the Province.

Data centres consume significantly higher energy per unit area than buildings used for other purposes, a reflection of the electricity needs of both the servers and the air conditioning units required to prevent overheating. GHG emissions from data centres worldwide are now estimated to be 157,000,000 tonnes of CO2e annually, and are anticipated to grow to 259,000,000 tonnes of CO2e in 2020[i]. This translates into roughly 2% of global GHG emissions for data storage alone, a figure comparable to the emissions from aviation. Given that the rapid growth in digital services appears likely to continue to grow significantly, the priority is to limit the negative environmental impacts from energy production. Pilot or model projects in BC could demonstrate leadership in this area internationally.

Background

There are two key opportunities to create greener data centres: lowering electricity use (energy efficiency), whether for the IT power draw or for cooling equipment, and/or re-using waste heat to displace other forms of energy use. Traditional (inefficient) data centres use 1 to 1.5 watts of electricity to cool the data centre for every 1 watt used to run the IT equipment, while some new and highly efficient data centres use as little is 0.2 watts per 1 watt of IT electricity[ii] (e.g. Google datacentres[iii]).

Recommendations

Conventional data centres are cooled by the circulation of cold air and by the removal of hot air through the use of air handlers and chillers. More innovative techniques are being created, and depending on the specific requirements, one or more of the following opportunities could be pursued;

Virtualization is a tool used to free up space and create more dense computing environments, while creating better utilization and efficiency of hardware. The work of 10 servers can often be replaced by one, thereby reducing energy use and improving utilization of the remaining server. Even idle servers consume 2/3rds of their total power, so inefficient use of servers (low utilization) can significantly increase unnecessary electricity demand and overhead.[iv]

Free-cooling is the use of outdoor air to cool the internal data centre, assuming the outdoor air temperature and humidity meet certain thresholds. In cooler, dry climates a significant amount of electricity can be saved by using the outdoor air as a cooling mechanism, rather than using chillers.[v]

Shipping, or modular, data centre containers are now in wide use at some of the largest data centres operated by Google and Microsoft. These are highly efficient, modular centres that minimize the amount of space and therefore the amount of air that must be circulated and cooled. PUEs (the Power Usage Effectiveness, defined as the total power usage of the data centre divided by the total power usage of the IT equipment) of shipping containers are between 1.4 and 1.8 depending on technology and configuration, and represent one of the quickest ways to achieve efficiency on new construction.

Cloud computing is emerging as a green option for organizations. Rather than hosting one or more servers internally that may sit idle much of the time and contribute to overhead, outsourcing a business's computing requirements to a third party usually ensures that servers are being run more efficiently and with higher utilization since the hosting company seeks to maximize its resources to make a profit[vi].

Liquid Cooling is the use of liquids to cool racks (the containers in which the servers sit) and even individual components within the server (CPUs). Efficiencies in cooling allow for more density of computing power while in some cases also cutting electricity costs.

The other key opportunity is re-use of waste heat. Data centres produce a significant amount of low-grade waste heat that can be captured and used to dry biomass and biosolids, heat greenhouses, or produce hot water for homes, pools or district heating. Such waste heat, if used efficiently and creatively to displace other forms of heating, could create carbon-positive data centres in BC. For example, consider the application of the waste heat from a 4 MW data centre used to warm a 5 hectare greenhouse in the lower mainland. A 4 MW data centre would produce 778 tonnes of CO2e and generate approximately 6,820,000 BTU/hr, enough to provide all the necessary heat in the wintertime. The displacement of natural gas by low-grade waste heat used to warm the greenhouse would generate approximately 1400 tonnes of CO2e savings, effectively making the data centre/greenhouse operation carbon positive. Similar scenarios exist for operations that would use the waste heat to dry biomass or heat homes. [vii]

Conclusion

BC, with its predominantly hydro-based electricity supply and up to 37,000 MW of untapped renewable resources, has a key advantage over other jurisdictions because of the low cost of generating electricity as well as the low carbon emissions generated from electricity production. Increasingly the cost of carbon is being included in all aspects of production and consumption, and energy use from IT sources is no exception. For both environmental and economic reasons, a low-carbon economic region will be a driving factor for many businesses, particularly for data centres and other businesses whose significant cost is electricity. Data centres offer a unique opportunity in that their physical location is independent of their actual use making them ideal candidates to locate near clean electricity or sources of biomass or biosolids. While there are many opportunities to create greener data centres, the greenest option is to combine energy efficiency measures with the waste heat reuse potential to create carbon-positive data centres in BC.

While BC offers significant opportunities for data centre development, a number of challenges exist. First, locations in the coast region are less attractive to data centre developers because of earthquake risks. Although this could represent a bonus for communities in the interior, developers may face the different challenge of attracting skilled IT professionals to rural regions. Second, while power in BC is cheap and has a low carbon footprint, other jurisdictions may offer comparable or cheaper power from excess capacity associated with nuclear or coal resources. Third, attracting large scale data centre developers will require a concerted marketing effort. This could be led by the provincial government and should target specific companies that would benefit from low carbon power sources.

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[i] The Climate Group, 2008. SMART 2020: Enabling The Low Carbon Economy in the Information Age. < http://www.smart2020.org/>

[ii] Fontecchio ,Mark. Data Center Location and the Cost of Power. 18 Mar 2010 <http://itknowledgeexchange.techtarget.com/data-center-facilities/data-center-location-and-the-cost-of-power/>.

[iii] Data Center Efficiency Measurements. 18 Mar 2010. <http://www.google.com/corporate/green/datacenters/measuring.html>

[iv] Blackburn, Mark. Five Ways to Reduce Data Center Server Power Consumption. The Green Grid. 2008. < http://doe.thegreengrid.org/files/temp/E12E5A57-B5B2-71A3-DF10D563C6676C23/White_Paper_7_-_Five_Ways_to_Save_Power.pdf>

[v] Munroe, Mark. Free Cooling Tool and Power Configuration Efficiency Estimator. The Green Grid. Presentation: February 2009, 18, Mar 2010. <http://thegreengrid.org/en/Global/Content/TechnicalForumPresentation/FreeCoolingToolPowerConfigurationEfficiencyEstimator>

[vi] Spellmann, Amy, Gimarc, Richard, Mark Preston. Leveraging the Cloud for Green IT: Predicting the Energy, Cost and Performance of Cloud computing. CMG December 6-11, 2009.

[vii] Greenhouse Heating and Venting: A Guideline for determining heating and venting requirements. < http://www.gov.mb.ca/agriculture/crops/greenhouse/bng01s04.html>